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AUTHOR Keller, Jack J.
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ABSTRACT

A fourth grade teacher and grade level team leader designed and implemented a 10-week practicum intervention meant to improve 26 fourth grade students' motivation, perseverance, and positive attitudes toward problem solving in mathematics. Students took part in activities that enhanced perceptual and deductive reasoning skills, including strategy games. Students were taught seven different problem solving techniques. Evaluation data indicated that there was positive transfer from instruction in strategy games to problem solving. Student attitudes improved, and perseverance and knowledge of problem solving techniques increased. Appendices provide a test of problem solving techniques, attitude inventory items, objectives or rules of games played, and tangram activities. (RH)

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STRATEGY GAMES: DEVELOPING POSITIVE ATTITUDES AND PERSEVERANCE TOWARD PROBLEM SOLVING WITH FOURTH GRADERS

by

Jack J. Keller

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A Practicum Report

submitted to the Faculty of the Center for the Advancement of Education at Nova University in partial fulfillment of the requirements for the degree of Master of Science.

The abstract of this report may be placed in a National Database System for reference.

June/1990

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Authorship Statement

I hereby testify that this paper and the work it reports are entirely my own. Where it has been necessary to draw from the work of others, published or unpublished, I have acknowledged such work in accordance with accepted scholarly and editorial practice. I give this testimony freely, out of respect for the scholarship of other workers in the field and in the hope that my work, presented here, will earn similar respect.

Signed Jack J. Keller

Abstract

Strategy Games: Developing Positive Attitudes and Perseverance Toward Problem Solving with Fourth Graders.
Keller, Jack J., 1990: Practicum Report, Nova University, The Center for the Advancement of Education.
Descriptors: Elementary Education/Mathematics/Word Problems/Problem Solving/Games/Strategy Games/Fourth Grade/Motivation/Attitudes/Perseverance

The lack of student motivation, perseverance, and positive attitudes toward problem solving among 26 fourth graders was addressed by the implementation of strategy games. Students were taught seven different problem solving techniques. The target group took part in activities that enhanced perceptual and deductive reasoning skills. Positive transfer from instruction in strategy games to problem solving did take place. The target group's attitude, perseverance, and knowledge of problem solving techniques did increase. Appendices include Test of Problem Solving Techniques, Attitude Inventory Items, Object or Rules of the Games, and Tangram Activities.

Appendix J

Nova University
Center For The Advancement of Education
3301 College Avenue
Fort Lauderdale, FL 33314

Observer Verification Form

Verification of Practicum Activity

Dear Observer:

Practicum students in Nova's M.S. and Ed.S. programs are asked to provide external verification that the project activities reported in their final practicum documents took place as described. You have been designated an observer to fulfill this confirmation function by the student named below. On this sheet, then, please write a note attesting to your knowledge of the project activity described in the final practicum report to which this will be attached. (Note that you are not asked to evaluate or make judgments about the quality of the project.)

Practicum Title Strategy Games: Developing Positive Attitudes and Perseverance Toward Problem Solving w/Fourth Gra

Student's Name Jack J. Keller

Program Site Carrollwood Elementary Date 6-18-90

Observer's Name Nelson Luis (please print---------and sign)

Observer's position Principal Phone # (813)935-8305

Observer's comment on impact of the project (handwritten):

The use of strategy games reinforced the use of problem solving techniques. Students observed were actively involved during the practicum sessions. Interest level was high to the benefit of learning by students

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CHAPTER I

Purpose

The writer of this practicum, a fourth grade teacher and grade level team leader , taught at the school site where this practicum took place. The writer taught social studies to the homeroom class and taught two classes of math and science. In addition to direct instruction of students, this writer served on several school and county-wide committees. The school committees included responsibilities as grade level team leader, social committee member, and closed circuit television producer. The county-wide responsiblities included: PRIME teacher, mathematics contact teacher, and a committee member to revise the mathematics program.

The suburban school site at which this practicum took place had an enrollment of 738 students in grades K-5. The majority of the student population (84 percent) came from White, upper middle class, two parent families who were quite active at the school site. While, the minority of the school population (16 percent) came from Black, low class, usually single parent families who were less involved in the

education of their children. The socio-economic level was reflected in the school lunch program. Only 22 percent of the school's population participated in the free or reduced lunch program, while 78 percent of the students bought or brought lunches.

The school's methodology was that of a traditional approach to learning. The target group, taught by this writer, was a fourth grade mathematics class. The class consisted of 26 students whose achievement levels were reported in the above average to average range, as reflected in norm-referenced Comprehensive Test of Basic Skills (CTBS) scores. The target group average score at the end of the third grade on the curriculum based Addison-Wesley End of the Year test was 93 percent.

The math curriculum consisted of the Addison-Wesley textbook and math kit. The textbook and kit supplied the teacher with the necessary tools to teach the three required components of mathematics. The three components of review and reinforce, mental arithmetic, and teacher-directed instruction were taught daily. Mathematics was taught one hour per day, with 20 minutes for review and reinforcement activities, 10 minutes for mental arithmetic, and 30

minutes designated for teacher-directed instruction.

The review and reinforcement activities supplied by the textbook publisher were inclusive in the teacher's edition. These review and reinforcement activities consisted of computational problems that were duplicated for classroom use. The premise for the review and reinforcement activities was to enable the student to maintain achievement levels.

The purpose of mental arithmetic drills was to enhance abstract thinking, by providing situational and computational problems to the student via the teacher's resources. Mental arithmetic was presented to students, individually or in groups.

New concepts or skills were taught by teacher-directed instruction to total class groups. The curriculum encouraged the use of manipulatives twice a week. These manipulatives were found within each math kit. Problem solving activities were incorporated into the teacher-directed instruction. The textbook publisher supplied word problems relevant to each concept that was taught. The supplement problem solving resource guide, Problem Solving Experiences in Mathematics, provided the means to demonstrate and teach problem solving techniques.

The symbolism of mathematics can be difficult to understand. Ginsberg (1977) indicated children already employ an understanding of informal arithmetic before they enter school. Counting serves the basis for this informal arithmetic. However, counting has limitations when transcending arithmetic to perform mathematical operations, such as multiplication and division. The student's transition from informal arithmetic to formal arithmetic takes place in an educational setting, usually a classroom. Formal arithmetic is codified; it is written and arranged systematically with explicit rules and procedures (Ginsberg, 1977).

The teaching of formal arithmetic has three major areas of emphasis: (1) facts and drills, (2) understanding, and (3) problem solving (Gandanidis, 1988). Facts and skills are more commonly referred to as computational skills, the use of rules and procedures applied to algorithms. Textbook publishers provide an over-abundance of facts and skills exercises. The emphasis here is "getting the right answer". The understanding of mathematics is what makes it meaningful to students. By understanding, the emphasis is shifted from "getting the right answer" to understanding how the answer was derived and why the

question was asked in the first place. This understanding of mathematics enables a student to find mathematics more interesting and less fearful. Problem solving allows the student to be creative and experience mathematics as less threatening than computing nonmeaningful systematic rules and procedures to obtain an answer. Problem solving elicits interpretations of the problem, strategies to solve the problem, and the means to solve the problem. Problem solving enables creativity by utilizing more than one concept and more than one strategy toward any given problem.

Problem solving is the area of mathematics that was of concern to this writer. The school's curriculum for mathematics specifies the time expended in each of the three components taught, but it allows freedom for teacher creativeness and teacher responsiveness to student need. However, teachers rarely use that freedom to respond to the student's needs in demonstrating alternative modes of explanation, more than one medium of expression, and flexibility in presentation (Gannon and Ginsberg, 1985). The educators at the school site were surveyed concerning the frequency of the use of manipulatives in teaching

mathematics. The primary teachers used manipulatives 2.7 days a week, while the intermediate teachers used manipulatives 1.0 day a week. Stake and Easley cited by Gibney and Karns (1977, p.358), wrote that...

> Mathematics instruction and mathematics teachers remain rather traditional. The textbook is the course of study, and the teacher's manual is the most extensively used supplement to the textbook. Hands-on materials that accompany textbooks are used in about one-third of the K-3 mathematics classes, but little threrafter in grades 4-12. From third grade through twelfth grade, students had few materials to manipulate. In most classrooms the source of knowledge certainly is still the textbook.

Reviewing the target group's achievement scores (Table 1, p.8) on the CTBS revealed that the group had a higher achievement level for computational skills (92 percent average) than conceptual and application skills (83 percent average). Since the mathematic curriculum was strongly based on the textbook and the textbook is 75 percent computational, it appeared that these scores reflected the traditional experiences that these students have had in mathematics.

The need for better problem solving skills was not only evident by looking at achievement test scores, but also looking at the number of failed objectives on curriculum based tests which were

criterion referenced. These curriculum based tests assessed both computational skills and problem solving skills. In analyzing the results of these test objectives (Table 2, p.9), three out of eight (38 percent) problem solving skill objectives were not mastered, while only six out of 37 (16 percent) computational skill objectives were not mastered. The higher level of mastery in the target group's achievement of computational skill objectives as compared with mastery of the problem solving skill objectives further supported the need to improve problem solving skills.

In the classroom setting, the writer had observed the lack of motivation and the lack of perseverance exhibited by the target group when receiving instructions and solving word problems. This lack of motivation and lack of perseverance contributed to poor problem solving behavior. Creativity was not evidenced in the otherwise rigid response style of these students. This rigidity may be a function of students "looking for the right answer" as a result of extensive focus on computation and "getting the right answer". It appears that student unwillingness to persevere was related to poor motivation. If, in

TABLE 1

Comparison of CTBS Computational Scores To
CTBS Conceptual and Application Scores

Student #	CTBS Comp	CTBS Concpt/Appl
1	98	78
2	*	*
3	98	99
4	90	99
5	*	*
6	98	85
7	98	72
8	*	*
9	90	78
10	90	85
11	62	91
12	98	78
13	*	*
14	90	85
15	79	51
16	90	72
17	90	91
18	98	91
19	98	85
20	90	91
21	*	*
22	98	78
23	98	78
24	98	85
25	*	*
26	90	85
Total Average	92	83

* Denotes New Student - scores not available.

TABLE 2

Comparison of Failed Computational Skill Objectives
To Failed Problem Solving Skill Objectives*

Student #	Computational Skill Objectives Failed	Problem Solving Skill Objectives Failed
1	4	1
2	2	2
3	3	1
4	5	2
5	2	1
6	8	7
7	16	5
8	13	5
9	2	2
10	7	6
11	3	1
12	8	6
13	3	0
14	12	4
15	14	5
16	5	2
17	9	1
18	3	0
19	3	2
20	2	1
21	4	2
22	4	4
23	5	3
24	6	4
25	2	3
26	12	4
Total Average	6 out of 37 Obj. Failed (16%)	3 out of 8 Obj. Failed (38%)

* Based upon the results of curriculum based tests which are criterion referenced. These curriculum based tests assessed 37 computational skill objectives and 8 problem solving skill objectives.

assessing student attitudes, motivation and perseverance increase, it may enable the student to be more successful with conceptual and application skills, along with computational skills.

This practicum was designed to provide the necessary experiences to increase motivation as manifested in the increase of positive attitudes and perseverance toward problem solving. This practicum extended over a period of ten weeks. During this time, the writer gave instructions on problem solving techniques, utilized games to develop strategies and perseverance, and facilitated small group discussions with the target group. It was anticipated that these experiences would increse motivation reflected in an increase in positive attitudes and perseverance.

After ten weeks of implementing strategy games and responding to student needs with alternative strategies, the outcome objectives were as followed:

1. The student would demonstrate the use of seven different problem solving techniques on the Test of Problem Solving Techniques (TPST) with a 50 percent increase from the pretest to the posttest. (Appendix A:38)
2. The individual student task perseverance would

increase 50 percent as measured by comparing length of time spent on pretest to length of time spent on posttest.

3. The student attitude toward problem solving would be significantly more positive, a 0.5 increase in the mean score in all categories, as measured by the Attitude Inventory Items during the first and tenth week of the practicum. (Appendix B:41)

CHAPTER II

Research and Solution Strategy

During the later years of the 1980's, the National Council of Teachers of Mathematics (NCTM, 1989) created 54 standards to be implemented in K-12 mathematic curriculums for the next decade. These standards focus on both mathematical ideas and processes and gives greater emphasis to conceptual development, mathematical reasoning, and problem solving. The standards were developed in response to a crisis in the teaching and learning of mathematics. This crisis was defined as poor student mathematical achievement in comparison to other highly developed countries. This crisis appears responsible for a shortage of well-qualified teachers, the existence of outdated curriculum, inadequate textbooks that shape the curriculum, and limited ways of measuring the outcomes of mathematics instruction. The NCTM (1989) evaluation of the K-4 curriculum found that the curriculum is narrow in scope; fails to foster mathematical insight, reasoning, and problem solving; and emphasizes rote activities. NCTM (1989,p.10) noted that "in many classrooms, learning is conceived of as

a process in which students passively absorb information, storing it in easily retrievable fragments as a result of repeated practice and reinforcement." NCTM not only reviewed mathematic curriculum, but observed the attitudes of students. Through this research, two significant factors were found to be related to negative attitudes toward mathematics. Students find the learning of mathematics purposeless when it loses its sense-making experience and students become passive receivers of rules and procedures rather than active participants in creating knowledge. Resnick, as cited by NCTM (1989, p.10), stated that "learning does not occur by passive absorption alone."

Experiences in the school setting impact attitudes and perseverance toward problem solving in mathematics. These experiences are of a progressive nature, encompassing both conventional and nonconventional learning experiences. Ratliff (1990) indicates that response to school curriculum is based on the learner's experiences along with the learner's interpretation of those experiences. Experiences of a positive nature tend to encourage further productive experiences in learning. Bloom (1976) writes that

these experiences are manifested in affective entry characteristics. These affective entry characteristics consist of subject-related affect, school-related affect, and academic self-concept all of which relate to the student's perception or attitude, negatively or positively, toward the learning experiences. In discussing motivation, Bloom (1976, p.104) states that "affect helps to determine the extent to which the learner will put forth the necessary effort to learn a specific learning task". Therefore, the task of the educator and student is to make educational experiences meaningful, both cognitively and affectively. To make an experience meaningful depends upon the "quality" of the experience. Dewey, as cited by Ratliff(1990, p.8), believes that "the quality of any experience has two aspects. There is an immediate aspect of agreeableness, and there is its influence upon later experiences." Bloom's (1976) research has shown that the educators feedback to the student's achievement, negatively or positively, has an impact on the student's affective entry characteristics. Therefore, the educator must promote experiences that will ensure student participation and encourage a positive approach to later experiences.

Glickman (1981) sees validity in educating children through play. Glickman accepts the following as elements of play: play is pleasurable, play is enjoyable, play is intrinsically motivating, and play involves activity. These elements of play can and should be used in the classroom setting to provide meaningful experiences in the learning process. Guided lessons which are carefully planned into play situations and implemented in activity centers, typically stimulate learning. Glickman (1981, p.48) implies that "play is crucial to development academically, cognitively, linguistically, socially, physically, and aesthetically." Recent research cited by Glickman (1981) and done by Pellegrini, 1980, has shown that there is a significant relationship between play and school achievement. Play encompasses the following qualities of problem solving: (1) reduction in the seriousness of the consequences of errors and setbacks, (2) a vehicle for exploration and invention, and (3) opportunities to internalize the external world (Bruner, 1983). Therefore, play is an essential tool in the teaching of students and should be incorporated into the traditional teaching methods to enhance classroom learning experiences (Bruner,

1983). Textbook publishers (Heath and Addison-Wesley) and conventional experts typically believe that the traditional teaching of problem solving skills consist of the student defining the problem, choosing a mathematical strategy to solve the problem, using the mathematical strategy, and then reviewing the solution to see if it resolves the problem. This traditional method provides the student with the mechanics of problem solving. It does not necessarily allow the student to be a participant learner. Usually, the traditional approach is pedantic. Willems (1981, p.13) stated that "conventional teaching is not very well suited for learning to make functional use of knowledge." Most conventional teaching is done by rote activities which incorporate the premise practice and only practice makes perfect.

Strategy games provide a link between traditional and progressive teaching methods of problem solving skills. Krulik and Rudnik (1983) compare the four conventional steps of problem solving with the four steps through which players must go when trying to develop a winning strategy for a particular strategy game. These steps for problem solving and playing a strategy game are as follows:

Problem Solving	Strategy Games
1. Read the problem - understand what is asked	1. Read the rules - understand the rules
2. Coorelate the known data with the unknown - develop a possible strategy	2. Coorelate the rules with those from any related game - select several possible strategies
3. Carry out the strategy	3. Carry out the strategy
4. Check the results - is the solution valid	4. Look back - if your strategy won, will it work every time

Fluck and Goldberg, cited by Krulik and Rudnick (1983), have shown that positive transfer from instruction in strategy games to problem solving does take place. To ensure transference of strategy gaming skills, discussions with the students is necessary (Krulik and Rudnick, 1983). These discussions should examine both winning and losing strategies, why these strategies won or lost, the ideas of defensive and offensive play, and why a certain line of play proved

successful or not. Such questioning will help to develop metacognition awareness (Costa, 1985).

Metacognition is being conscious of one's own thinking and problem solving while thinking (Costa, 1985). It is an awareness which develops by observing one's actions and reflecting on what one observes. Students must be watchers, analyzers, assessors, and evaluators of their own mathematical problem solving skills (Garofalo, 1987). Strategy gaming provides the opportunity for students to develop metacognition awareness. Besides developing strategy skills in problem solving and developing metacognition awareness, strategy games provide a motivational force which creates an atmosphere that is conducive to learning. This motivational force is manifested in the student's attitude.

Research (Whitaker, 1982) reflects that most elementary students do not have negative attitudes toward mathematics until the fourth grade. However, negative student attitudes change when teachers use meaningful methods of teaching mathematics. Negative attitudes become positive and positive attitudes become enhanced. Ediger (1978, p.74) believes that "pupils who have good attitudes toward learning can

achieve optimal development in mathematics understandings and skills." Mathematic teachers who provide meaningful learning activities and interesting classroom experiences tend to generate purposeful activities for students which are likely to result in improved attitudes which ultimately result in higher student achievement (Bloom, 1976).

Thus, research done by Krulik and Rudnick (1983) would appear to support the use of strategy gaming as a means of increasing positive attitudes toward mathematic problem solving, with an increase in positive attitudes an increase in perseverance and achievement would be anticipated. A pretest of problem solving techniques and an inventory of student attitude toward problem solving was administered prior to the implementation of this practicum. It was expected that this practicum would supplement, not replace the present curriculum. Thus, the activities of the traditional curriculum were used in addition to the strategy gaming techniques.

CHAPTER III

Method

Resource

This practicum was implemented over a ten week period, during which the target group was exposed to instruction of problem solving techniques, deductive reasoning skills, and perceptual thinking skills; while simultaneously exposed to transferring strategy gaming into strategic problem solving.

The writer taught seven problem solving techniques:

1. Guess and check
2. Draw a picture
3. Make a list
4. Make a table
5. Look for a pattern
6. Work backwards
7. Logical reasoning

Each week of the practicum period, the writer instructed the target group on one of the seven problem solving techniques. Word problems were used from the teacher's textbook resource supplement, Problem Solving Experiences in Mathematics authored

by Charles, Mason, and Martin (1985) to illustrate the use of the problem solving techniques. These word problems were copied onto overhead transparencies and used with the target group. Strategies to solve these word problems were discussed and explored with the target group. The problem solving techniques that were taught are referenced in Figure 1, p. 27 under the textbook title.

Perceptual thinking skills were enhanced through the use of tangram activities. The target group made tangram pieces from ditto paper which were used to piece together the various tangram puzzle designs. The writer encouraged perseverance by providing alternative means of looking or perceiving the tangram puzzle. Tangram puzzles were given to the target group three days a week during the last two weeks of the practicum period. (refer to Figure 1, p.27)

Mind Benders authored by Harnadek (1978) was used to develop deductive reasoning skills. The first two Mind Benders activities were completed with the target group with assistance from the writer. This enabled the students to understand the purpose of the activity and how to succeed in performing the activity, as very few students had previous

experiences with such problems that require deductive reasoning with the use of a matrix chart. After completion of the first two Mind Benders activities, the target group was given three Mind Benders per week for eight weeks. As each Mind Benders activity was dispersed to the target group, the writer discussed via the overhead transparencies, the solutions to the Mind Benders activity from the preceeding days.

To encourage the use of strategy skills and increase motivation and perseverance, commercial strategy games were played in small groups twice a week. During this time, small group discussions took place. During the playing of the games, probing questions were asked by the writer to the students. The students were asked if there was a strategy for winning, what strategies did not produce a win, were the moves during the game offensive or defensive, were the player's moves analyzed, and would the winning strategy work next time. The following games were used (Appendix C:43): Chinese Checkers, Checkers, Mastermind, Think Tac-Toe, Think Ominoes, Think and Jump, and Chess. The games used, which were suggested in the article, "Games That Help Kids Learn" (1981),

were selected for their usefulness in teaching strategy skills. The games referenced in Figure 1, p. 27 are found in Appendix C:43.

The teacher-made materials and manipulatives were a part of the mathematics curriculum. Therefore, there was no additional purchase cost associated with these items. The cost of the games ranged from three to seven dollars each, with the total cost of two hundred dollars to implement the practicum. The funds to purchase the games was obtained through the parent-teacher association (PTA).

Monitoring

Monitoring of the practicum progress was completed, via the writer, through observations and evaluation of the students' problem solving improvement within the standard mathematics curriculum. During the teaching of the standard textbook curriculum, the writer monitored the target group's ability to transfer the practicum activities to the standard mathematics curriculum. The writer noticed that the target group, when confronted with word problems in the textbook, began to use appropriate problem solving strategies. Thus, through

monitoring during the practicum activities and during the standard mathematics curriculum, the target group was progressing and changes were not warranted or needed.

Evaluation

The evaluation of the practicum objectives were measured through the use of informal and formal tests. The informal test, which lacks nationally devised norms or significant statistical data, was used to measure student knowledge of problem solving techniques and perseverance. While, the formal test was used to measure student attitude toward problem solving.

The informal teacher-made test was entitled Test of Problem Solving Techniques (Appendix A:38). This instrument used to evaluate pre and post levels of performance explicitly reflected the student's knowledge of problem solving techniques taught. This test consisted of ten word problems in which all seven problem solving techniques were tested at least once. Comparing the pretest and posttest difference scores demonstrated the extent to which students had a better understanding of what problem solving techniques

needed to be used, how to use them, and when to use the techniques. This test was also used to measure student perseverance. Increase in perseverance was measured by looking at the difference in time it took to complete the pretest and the time it took to complete the posttest while comparing the difference of time to the percentage difference of the pre and post test scores. This ratio format eliminated misleading statistics which would reflect an increase in time without a concomitant increase in mastery.

The formal evaluation used was the Attitude Inventory Items (Appendix B:41). This inventory, which was developed by Indiana University, was used to evaluate student attitude toward problem solving. This inventory which evaluated willingness, perseverance, and self-confidence was used in a small sample of intermediate level students. The mean score on the inventory was 12.83 (based on 20 points), while the mean scores on the subcategories were as follows: willingness, 4.34 (based on six points); perseverance, 3.94 (based on six points); and self-confidence, 4.55 (based on eight points). This inventory was given to the target group at the beginning and end of this practicum. Increase in positive attitudes was measured by increased scores on the inventory.

FIGURE 1

Chart of Implementation Activities

Week of:	Strategy Games	Instruction of Problem Solving Technique *	Mind Benders **	Assessment
March 12	Chinese Checkers	Guess & Check	Activities #1-4	-Test of Problem Solving Techniques -Attitude Inventory Items
March 19	Checkers	Draw a Picture	Activities #5-7	
March 26	Mastermind	Make a List	Activities #8-10	
April 2	Think Tac-Toe	Make a Table	Activities #11-13	
April 9	Think Ominoes	Look for a Pattern	Activities #14-16	
April 23	Think and Jump	Work Backwards	Activities #17-19	
April 30	Chess	Logical Reasoning	Activities #20-22	
May 7	Chess	Review	Activities #23-25	
May 14	Chess Tournament	Review	Tangram Activities	
May 21	Student Choice	Review	Tangram Activities	-Test of Problem Solving Techniques -Attitude Inventory Items

* Charles, Randall I., Robert P. Mason, and Linda Martin. Problem Solving Experiences in Mathematics. California: Addison-Wesley, 1985.

**Harnadek, Anita. Mind Benders - Al Deductive Thinking Skills. California: Midwest Publications, 1978.

CHAPTER IV

Results

This practicum was implemented to enhance the standard mathematics curriculum while focusing on three dependent variables: (1) increasing student knowledge of problem solving techniques, (2) increasing student problem solving perseverance, and (3) increasing positive attitude toward problem solving.

The TPST (Appendix A:38) was administered to the target group during the first and tenth week of this practicum period. This test was used to evaluate the target group's knowledge of problem solving techniques and problem solving perseverance, objectives one and two respectively. The results of the pre and post practicum TPST test (Appendix A:38) indicates that the target group failed to achieve objectives one and two (refer to Table 3, p.29). There was a mean score increase of 12.12 percentage points, which is approximately 35 percent increase from the pre to post test scores. Perseverance increased 0.73 minutes. A significant change from the pretest scores to the posttest scores is reflected in Table 3, p.29.

Table 3

Statistics for the Test of Problem Solving Techniques (Target Group)

	Score (%)		Time (min.)	
	Pretest	Posttest	Pretest	Posttest
Mean	35	47.12	25.19	25.92
Median	30	50	23	26
Mode	30	60	18	30
Range	70	70	35	27

The median difference in the pre and post test scores increased by 20 percent and perseverance increased by three minutes. The mode difference depicts an increase of 30 percentage points and an increase in perseverance of 12 minutes. Thus, implying that more students scored higher and persisted longer on the posttest than on the pretest.

The target group was given the Attitude Inventory Items (Appendix B:41), during the first and tenth week of this practicum, to measure change of attitudes toward problem solving. The Attitude Inventory Items (Appendix B:41) evaluated three categories of problem solving attitudes, those being: willingness, perseverance, and self-confidence. The inventory results reflect increased mean scores in all three

categories (Table 4,p.31). Willingness and self-confidence mean scores increased by .42 and .47 respectively. While, the perseverance mean score increased by .50. The median for willingness was unchanged, while the median increased by 1.0 in the perseverance and self-confidence categories. These scores suggest that more of the students scored higher on the post practicum inventory, which indicates a positive change in perseverance and self-confidence toward problem solving. Another significant statistic which increased was the mode. The mode increased by 1.0 in the categories of willingness and perseverance, while increasing 3.0 in the area of self-confidence. Again, the scores suggest the increase was significant enough to have produced a positive change in the target group's attitude toward problem solving. Although, two of the categories did not meet the expectations of objective three, the increase in positive attitudes is still significant. Consequently it was possible to conclude that a positive change in the target group's attitude toward problem solving resulted from the implementation of this practicum.

Table 4

Statistics for the Attitude Inventory Items
(Target Group)

Categories	Pretest Mean	Posttest Mean	Pretest Median	Posttest Median	Pretest Mode	Posttest Mode	Pretest Range	Posttest Range
Willingness	4.27	4.69	5.0	5.0	5.0	6.0	4.0	5.0
Perseverance	4.96	5.46	5.0	6.0	5.0	6.0	4.0	3.0
Self-Confidence	5.65	6.12	6.0	7.0	5.0	8.0	6.0	6.0

During the practicum there were several extraneous variables which interrupted the continuity of the practicum. These extraneous variables consisted of school-wide assemblies, plays, and meetings in which students lost mathematics class time. The implementation and timeline of the practicum was followed by the writer and the target group, although, many students were inhibited by the rescheduling and shuffling of class time due to the extraneous variables. An intervening variable which may have had a negative effect on the practicum was the writer's absence for a week to be the liason for the school at a national convention. During the writer's absence, the substitute was informed of the practicum activities for that week. The time period, at the end

of the school year during which the practicum took place, had an impact on the practicum. During the last two weeks of the practicum, the students began to realize that the school year was soon coming to an end and motivation and concentration tended to lessen. These factors may account for the objectives not meeting expectations.

In closing, the target group may have not met the objectives the writer anticipated, but there were positive changes in knowledge, attitude, and perseverance toward problem solving to warrant the implementation of this practicum and consideration of replication.

CHAPTER V

Recommendations

Students need to be encouraged to become active participants in the learning process. This practicum addressed the issues of motivation by approaching individual perseverance and positive attitudes about problem solving as key elements in change.

Focusing on student attitudes toward problem solving, in addition to task completion, is a critical component of teaching thinking skills. This practicum could be used in the fourth grade throughout the county's schools. It could be used at all grade levels in mathematics. It could also be used in other subject areas as well. For instance, Boggle could be played for its use of developing vocabulary, word attack, and spelling skills. While, The Game of the States reinforces comprehension skills.

The writer submitted a copy to the county's elementary supervisor for mathematics. In addition, the writer shared this practicum with colleagues at the school site where the practicum took place. The practicum not only serves to encourage students to become active participants in the learning process,

but will also encourage teachers to utilize their freedom for creativeness to enhance teacher responsiveness to student need.

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Appendix A

TEST OF PROBLEM SOLVING TECHNIQUES

Name: _____ Start Time: _____

Date: _____ End Time: _____

Difference: _____

Directions: Solve each problem and show your work.
Name the problem solving technique used.

1. Bobby, John, Russell, and Paul played checkers. Each boy played each of the other boys one game. How many games were played in all?

2. Beth had $0.33 in her purse. She had 9 coins. She did not have a quarter. What were the coins she had in her purse?

3. Bob and Ted were working in the orchards picking apples. Bob picked 9 bushels of apples a day and Ted picked 11 bushels a day. How many bushels will Ted have picked when Bob has picked 81 bushels?

4. Dori and Patti put up a rope to mark the starting line for the sack race. The rope was 10 meters (m) long. They put a post at each end of the rope and at every 2 meters. How many posts did they use?

5. The sum of the ages of three children is 22. Ruth is the oldest. Mark is not the youngest. John is 6 years younger than the oldest, who is 10 years old. What is Mark's age?

6. Lisa wants to participate in 2 running events in the track meet. She can select from the 50-m dash, 75-m dash, 100-m dash, and 400-m relay. How many different choices does Lisa have?

7. When Michael came home from Ellen's party, he told his mother about the 5 girls that were there. Barbara wore a red dress and Ellen wore a blue one. Mindy did not wear yellow. Sara and the girl in green won a contest against Barbara and the girl in yellow. He liked the girl in the brown skirt best. What color did Janice wear, and whom did Michael like best?

8. Pam checked a book out of the library and read this notice about fines: If a book is 1 day overdue, the fine is $0.01, 2 days overdue, $0.02, 3 days overdue, $0.04, and so on. If Holly's book is 7 days overdue, how much is her fine?

9. Peter and James each began to reading a Hardy Boys book today. If Peter reads 8 pages each day and James reads 5 pages each day, what page will James be reading when Peter is reading page 56?

10. A flock of birds were migrating south. 16 birds died in an early frost. 23 birds decided to go west. 40 birds lost their way. 96 birds arrived in the south. How many birds started the trip?

Source: Charles, Randall I., Robert P. Mason, and Linda Martin. Problem Solving Experiences in Mathematics. California: Addison-Wesley, 1985.

Appendix B

ATTITUDE INVENTORY ITEMS

Pretend your class has been given some math story problems to solve. Mark true or false depending on how the statement describes you. There are no right or wrong answers for this part.

___ 1. I will put down any answer just to finish a problem.

___ 2. It is no fun to try to solve problems.

___ 3. I will try almost any problem.

___ 4. When I do not get the right answer right away I give up.

___ 5. I like to try hard problems.

___ 6. My ideas about how to solve problems are not as good as other students' ideas.

___ 7. I can only do problems everyone else can do.

___ 8. I will not stop working on a problem until I get an answer.

___ 9. I am sure I can solve most problems.

___10, I will work a long time on a problem.

___11. I am better than many students at solving problems.

___12. I need someone to help me work on problems.

___13. I can solve most hard problems.

___14. There are some problems I will just not try.

___15. I do not like to try problems that are hard to understand.

___16. I will keep working on a problem until I get it right.

___17. I like to try to solve problems.

___18. I give up on problems right away.

___19. Most problems are too hard for me to solve.

___20. I am a good problem solver.

Scores: willingness_____

perseverance_____

self-confidence_____

Source: Charles, Randall, Frank Lester, and Phares O'Daffer. How to Evaluate Progress in Problem Solving. Virginia, NCTM, 1987.

Appendix C

THE OBJECT OR RULES OF THE GAMES

Chinese Checkers (2 - 6 players):

The object of the game is to move all of your pieces (marbles) to the direct opposite side of the game board, by jumping over your own game pieces or your opponent's game pieces. The player who gets all of their pieces on the side that is opposite them, wins the game.

Checkers (2 players):

The object of the game is to capture all of the opponent's men, or block them so they cannot be moved.

Mastermind (2 players):

The object of the game is to guess a secret code consisting of a series of four colored pegs. Each guess results in feedback narrowing down the possibilities of the code. The winner is the player who solves his opponent's secret code with fewer guesses.

Think Tac-Toe (2 players):

The object of this game is to try to fit the game's 12 pieces back into the tray in any one of the four solutions. Whichever player has the quickest solution wins.

Think Ominos (2 players):

The object of this game is to place the game pieces back into the tray matching color dots to facing color dots on each side of the six-sided dominos.

Think and Jump (2 players):

To play this game, the player begins by removing the orange peg from the center of the hexagon-shaped grid. Then, moving in any direction within the grid, jump over one peg at a time, removing the jumped peg--unti only one peg is left. The player with the fewest number of pegs left wins.

Chess (2 players):

The object of the game is to force a position, called "checkmate", in which the enemy king is subject to capture and there is no way to avoid the threat.

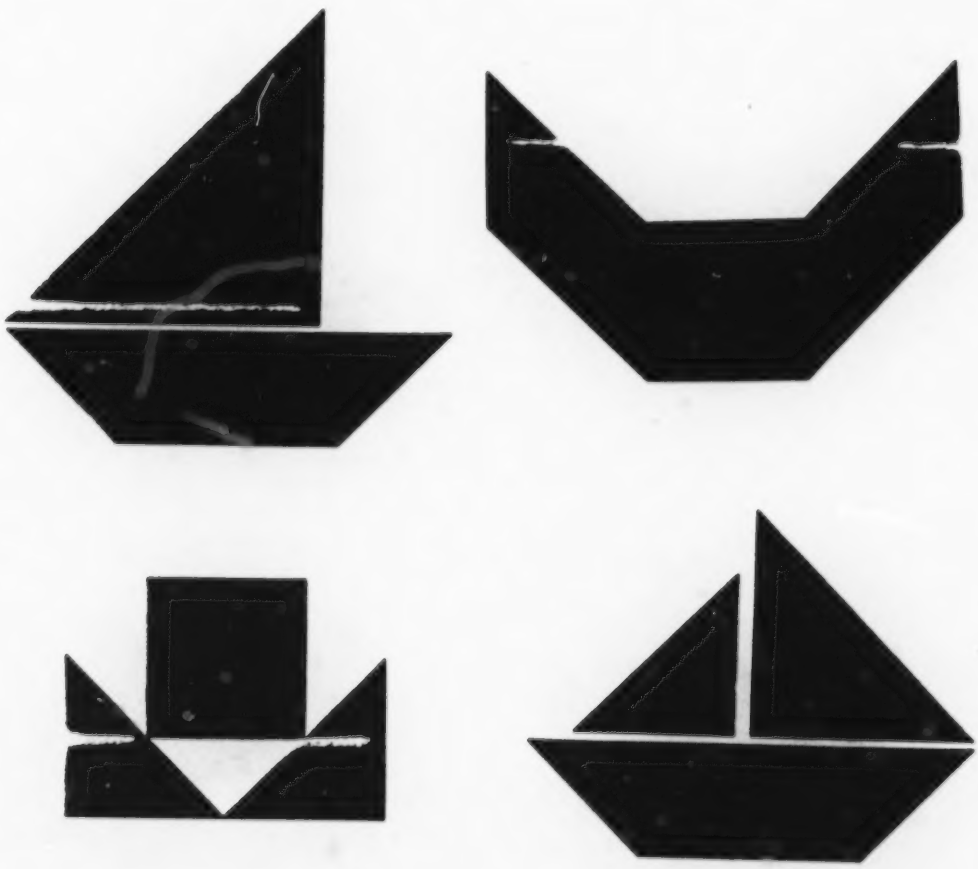
Appendix D

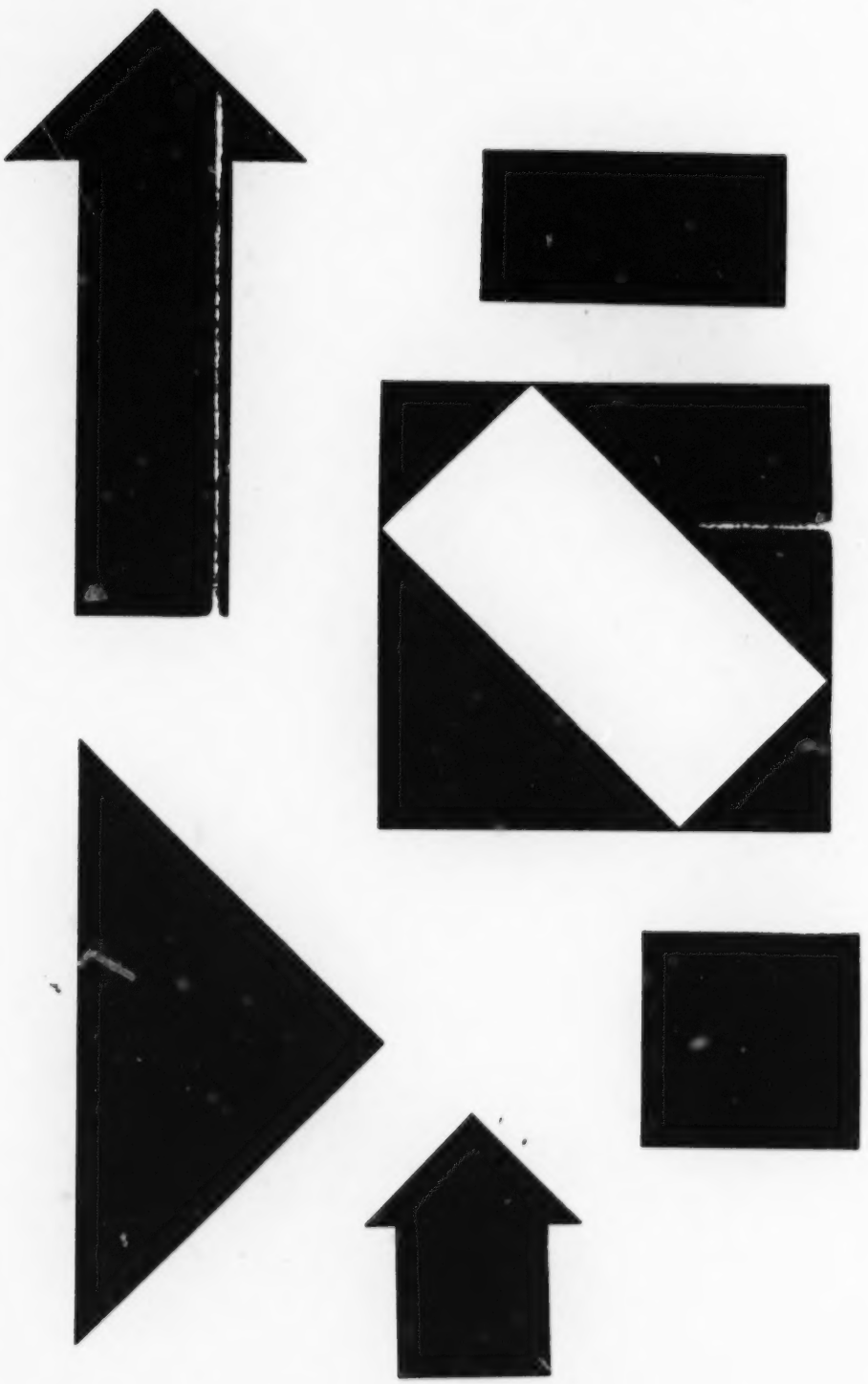
TANGRAM ACTIVITIES

Tangram activities provide the opportunity to develop shape concepts, perception of spatial relationships, visual discrimination, visual memory, thinking, and problem solving skills.

The first ten Tangram activities are figures that use two to five pieces per puzzle. The following 20 Tangram activities are a potpourri of everyday objects. Each of these puzzles use all seven pieces.

Source: American Teaching Aids
4325 Hiawatha Avenue
Minneapolis, Minnesota 55406





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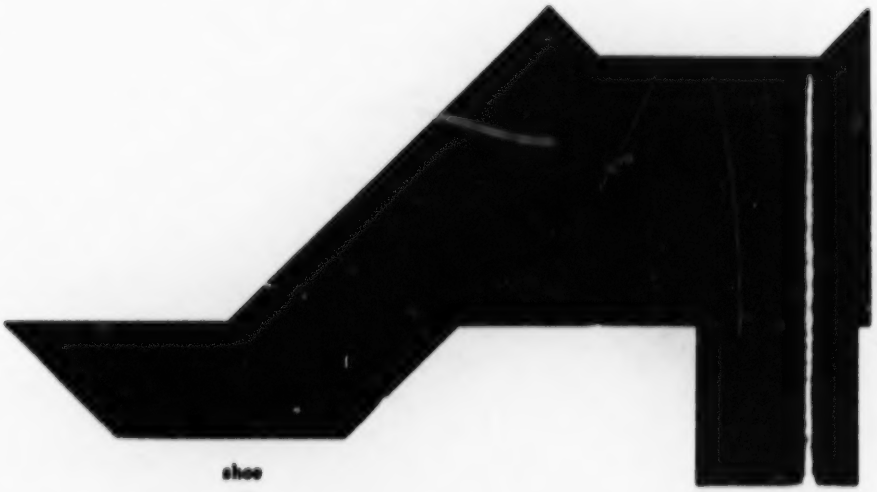

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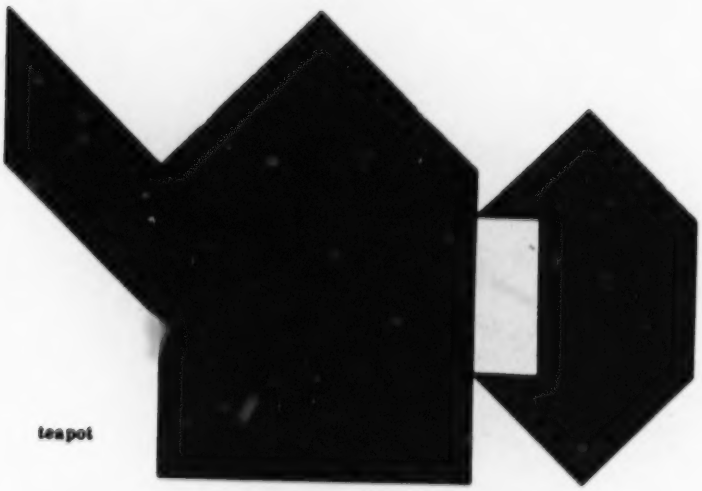

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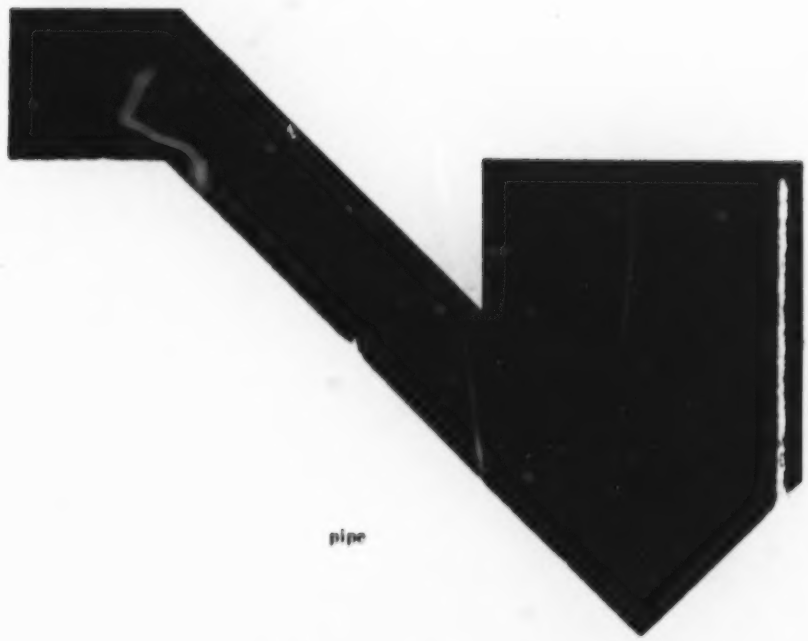

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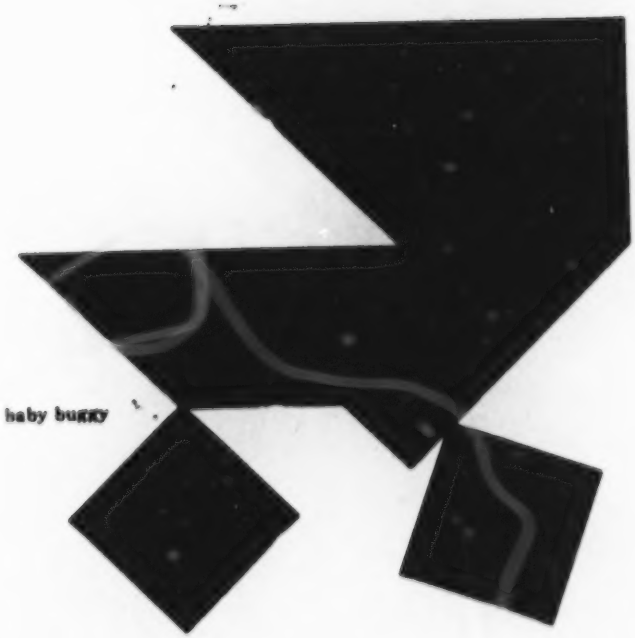
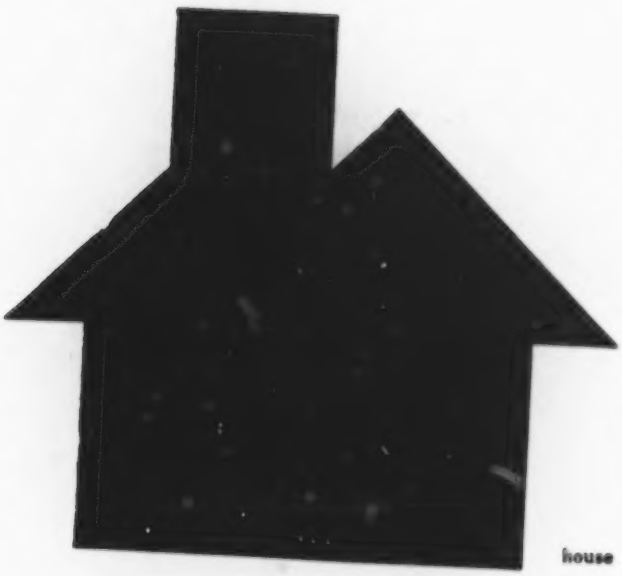


baby bunny



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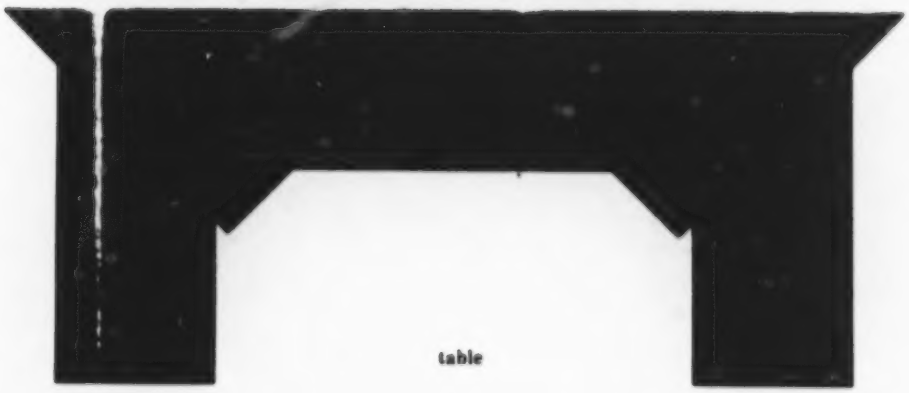

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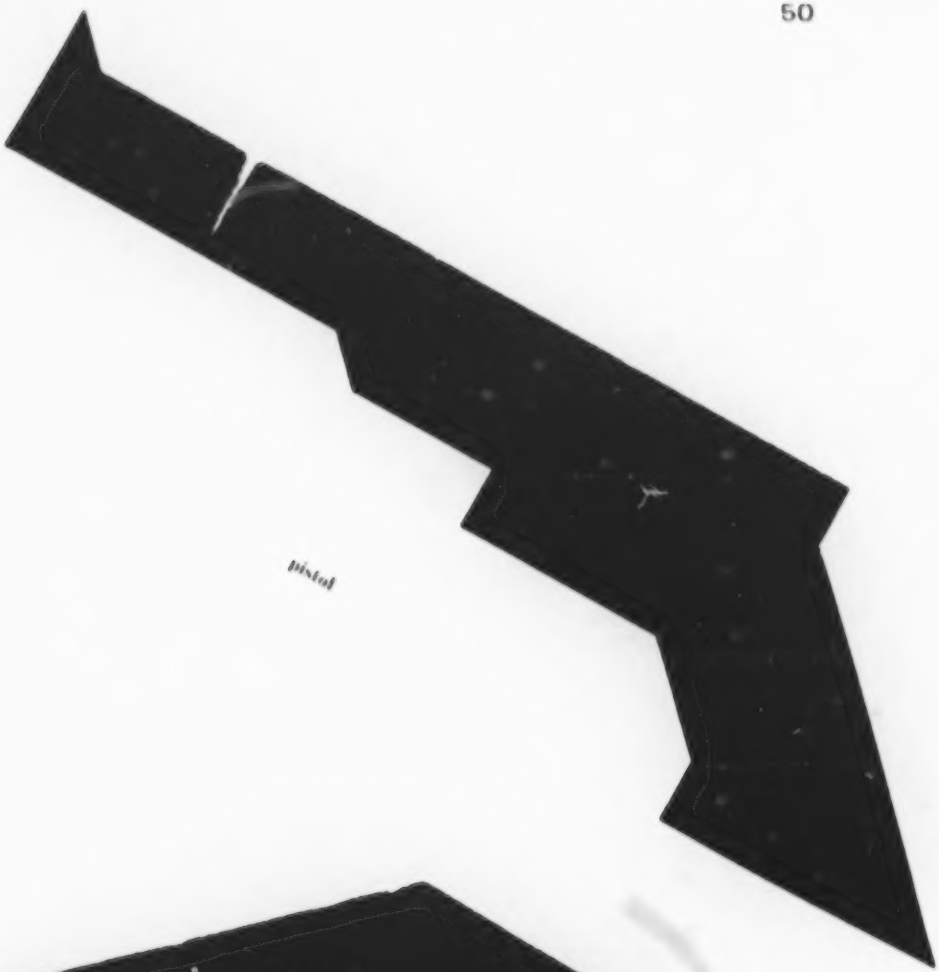

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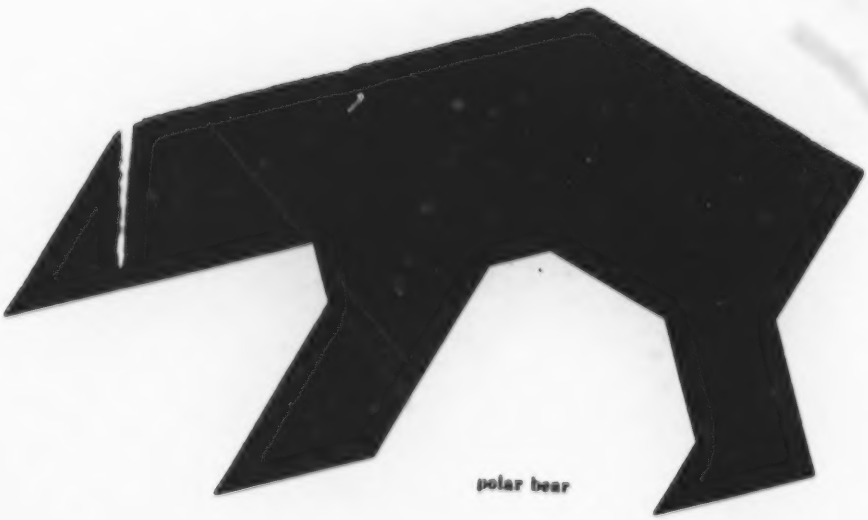

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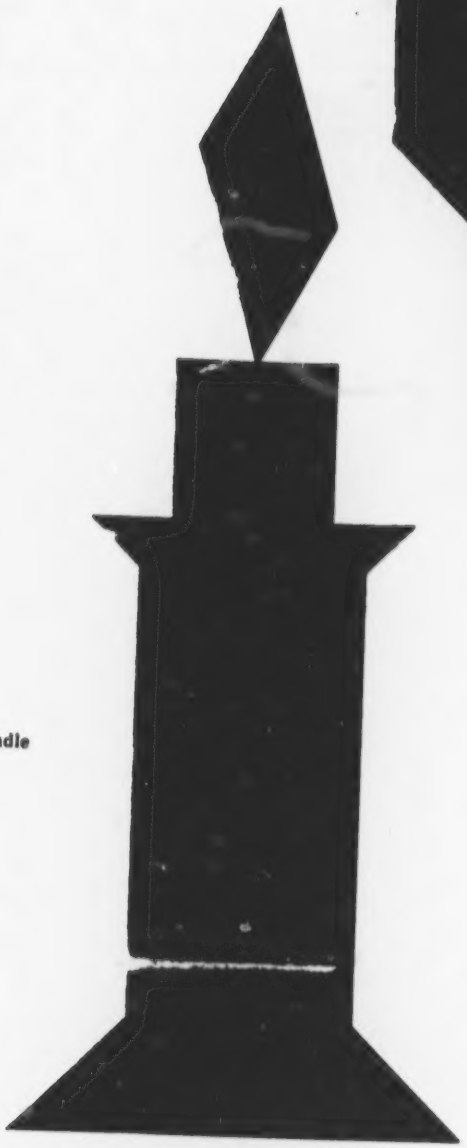
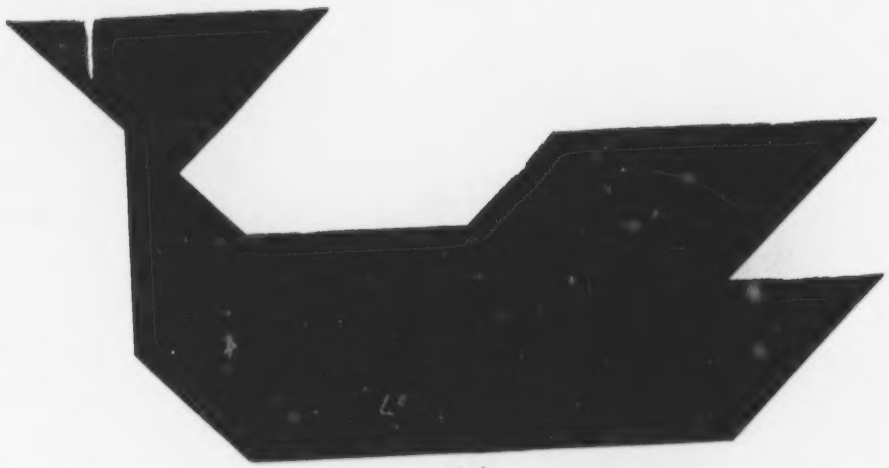
camel



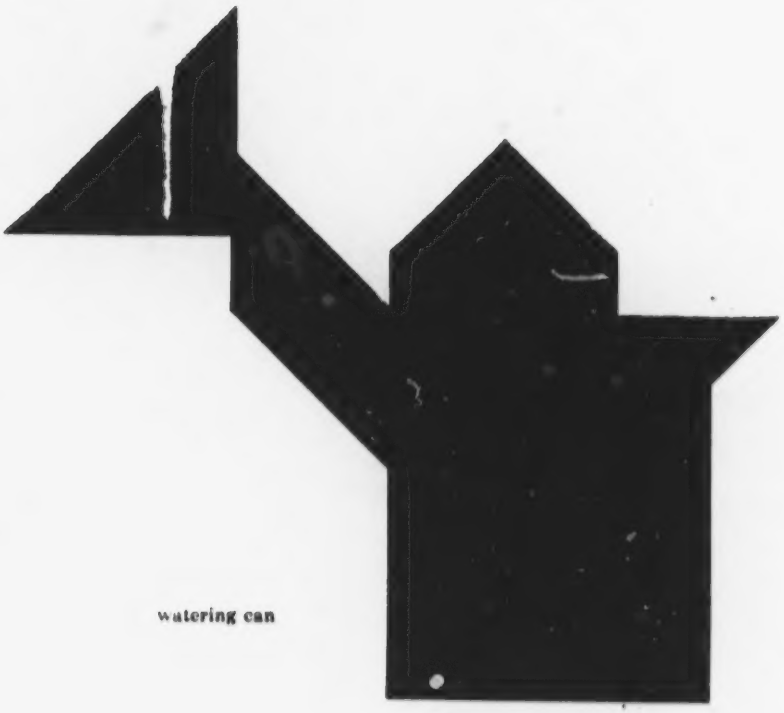
candle



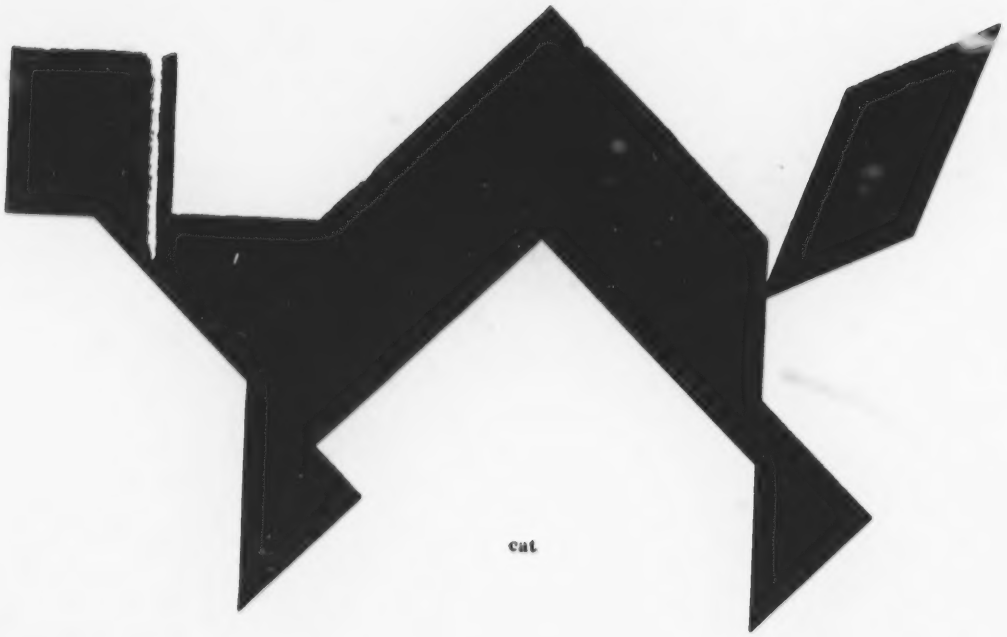
whale

giraffe

53



watering can



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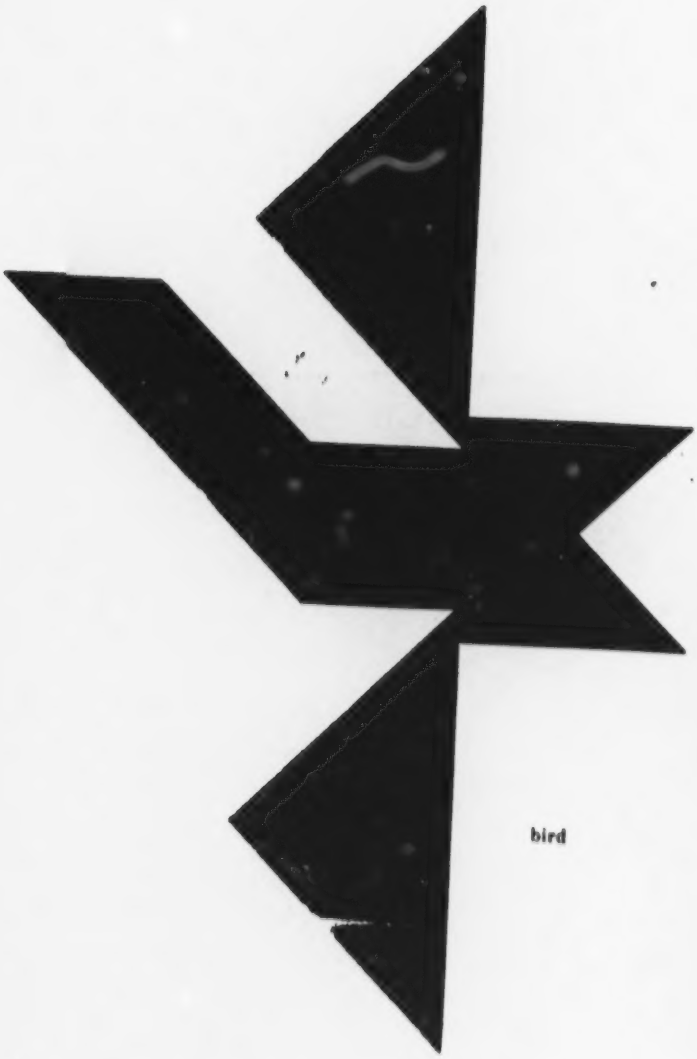

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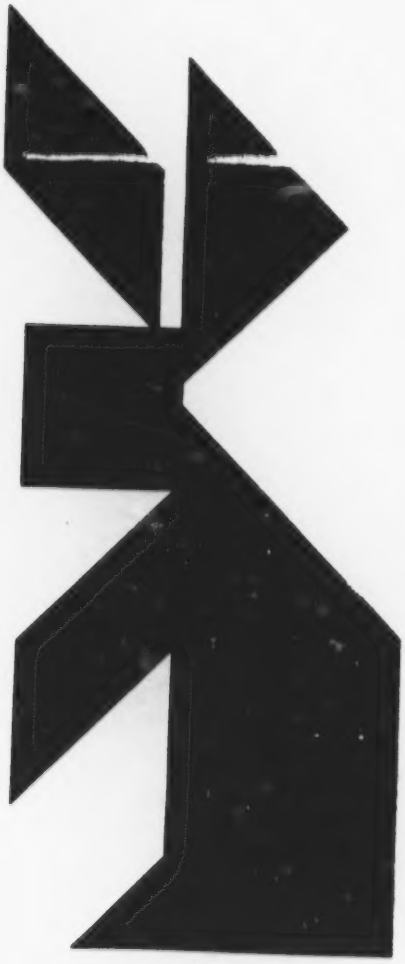

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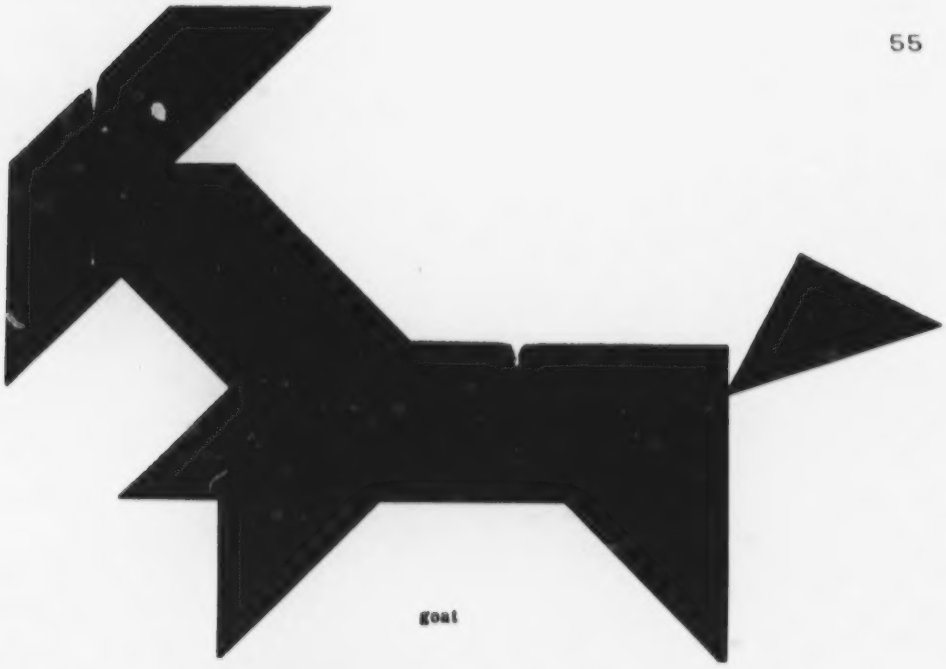

goat

chair